GROUP 35B

ANTI-SKID BRAKE SYSTEM (ABS)

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GENERAL INFORMATION

M2351000100409

FEATURES

The ABS ensures directional stability and controllability during hard braking.
For vehicles with this type of ABS, 4 sensors (4 channels) are installed on front and rear wheels allowing independent left and right control.
The system has the following features:

- EBD (Electronic Brake-force Distribution system) control has been added to provide the ideal braking force for the rear wheels.
- Magnetic encoder for wheel speed detection has been installed as a sensing device instead of the rotor.
- For wiring harness saving and secure data communication, CAN* bus has been adopted as a tool of communication with another ECU.

*NOTE: *: For more information about CAN (Controller Area Network), refer to Group 54C, General Information P.54C-2.*

EBD CONTROL

In ABS, electronic control is used so the rear wheel brake hydraulic pressure during braking is regulated by rear wheel control solenoid valves in accordance with the vehicle's rate of deceleration, and the front and rear wheel slippage which are calculated from the signals received from the various wheel speed sensors. EBD control provides a high level of control for both vehicle braking force and vehicle stability.
The system has the following features:

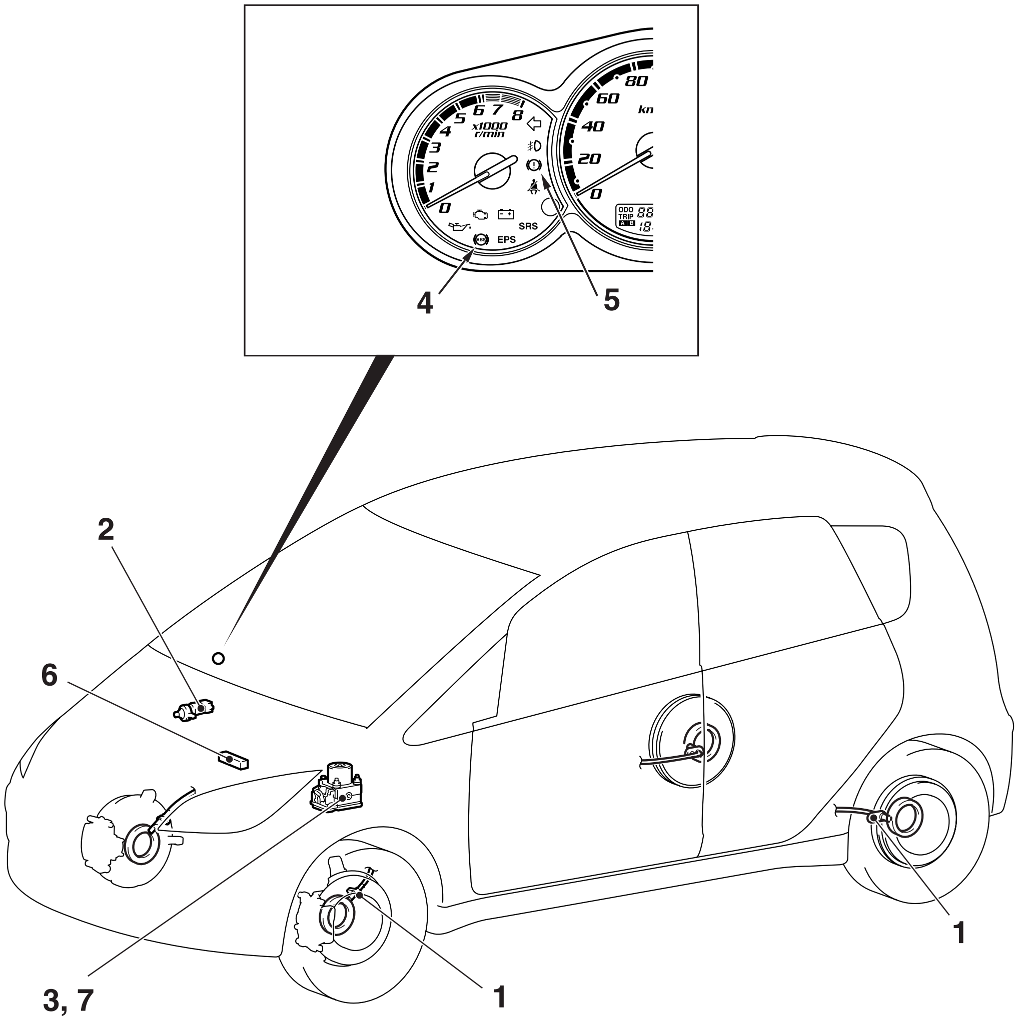
- Because the system provides the optimum rear wheel braking force regardless of vehicle load condition and the condition of the road surface, the system reduces the required pedal depression force, particularly when the vehicle is heavily loaded or driven on road surfaces with high frictional coefficients.
- Because the duty placed on the front brakes is reduced, the increase in pad temperature can be controlled during brakes application to improve the wear resistance characteristics of the pad.
- Control valves such as the proportioning valve are not required.

SPECIFICATIONS

Item			Specification
ABS control method			4-sensor, 4-channel
Wheel speed sensor	Magnetic encoder	Front	86 (N pole:43 S pole:43)
		Rear	86 (N pole:43 S pole:43)
	Type		Semiconductor

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CONSTRUCTION DIAGRAM

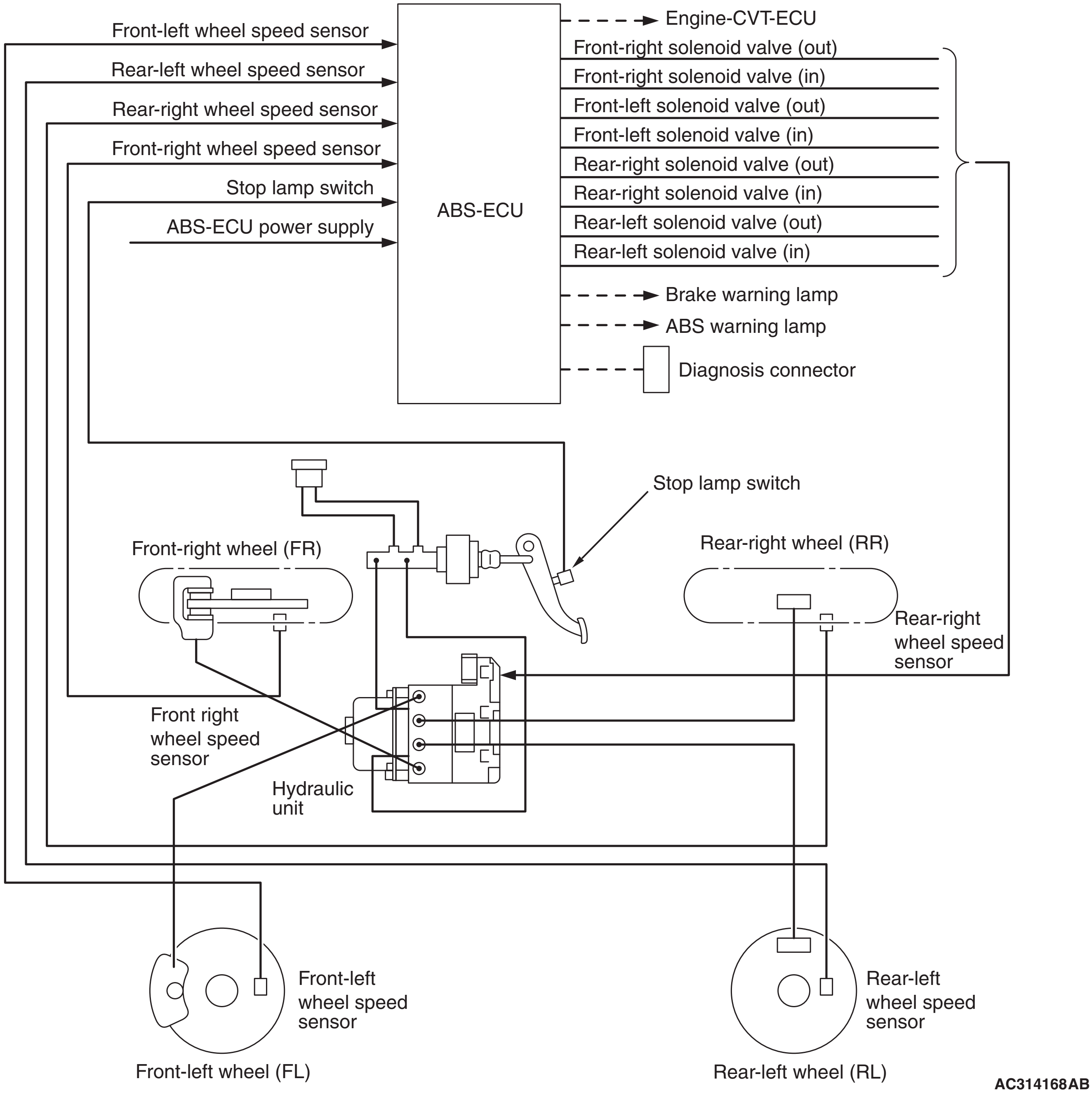


AC400129AB

Name of part		Number	Outline of function
Sensor	Wheel speed sensor	1	Sends alternating current signals at frequencies which are proportional to the rotation speeds of each wheel to the ABS-ECU.
	Stop lamp switch	2	Sends a signal to the ABS-ECU to indicate whether the brake pedal is depressed or not.
Actuator	Hydraulic unit	3	Drives the solenoid valves according to signals from the ABS-ECU in order to control the brake hydraulic pressure for each wheel.
	ABS warning lamp	4	Illuminates in response to signals from the ABS-ECU when a problem develops in the system.
	Brake warning lamp	5	Illuminates in response to signals from the ABS-ECU when a problem develops in the EBD system.
Diagnosis connector		6	Outputs the diagnosis codes and allows communication with the M.U.T.-III.
ABS-ECU		7	Controls actuators (described above) based on the signals coming from each sensor.
			Controls the self-diagnosis and fail-safe functions.
			Controls the diagnostic function (M.U.T.-III compatible).

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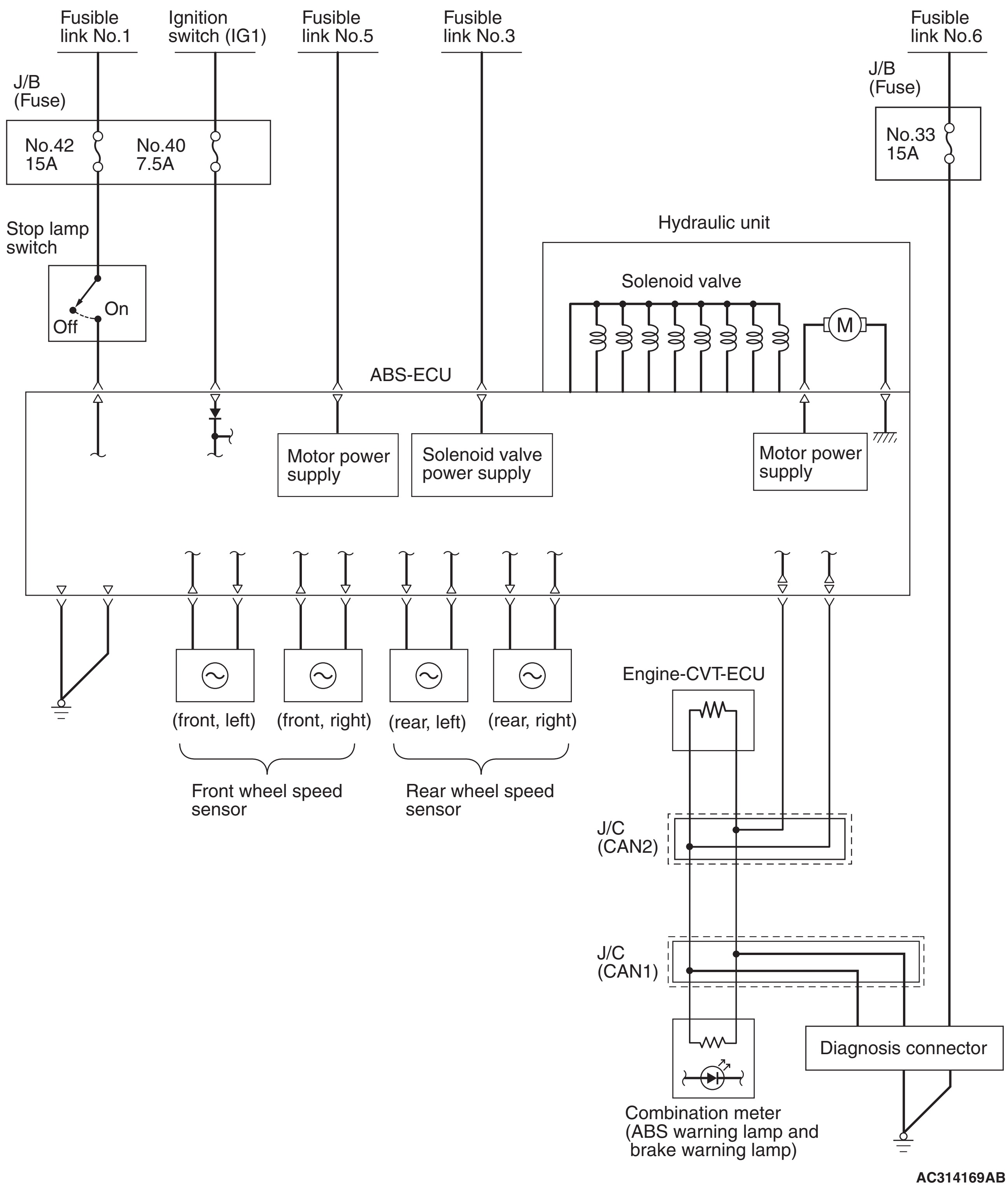
SYSTEM CONFIGURATION DIAGRAM



NOTE: Broken lines show CAN-bus line.

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ABS ELECTRICAL CIRCUIT DIAGRAM



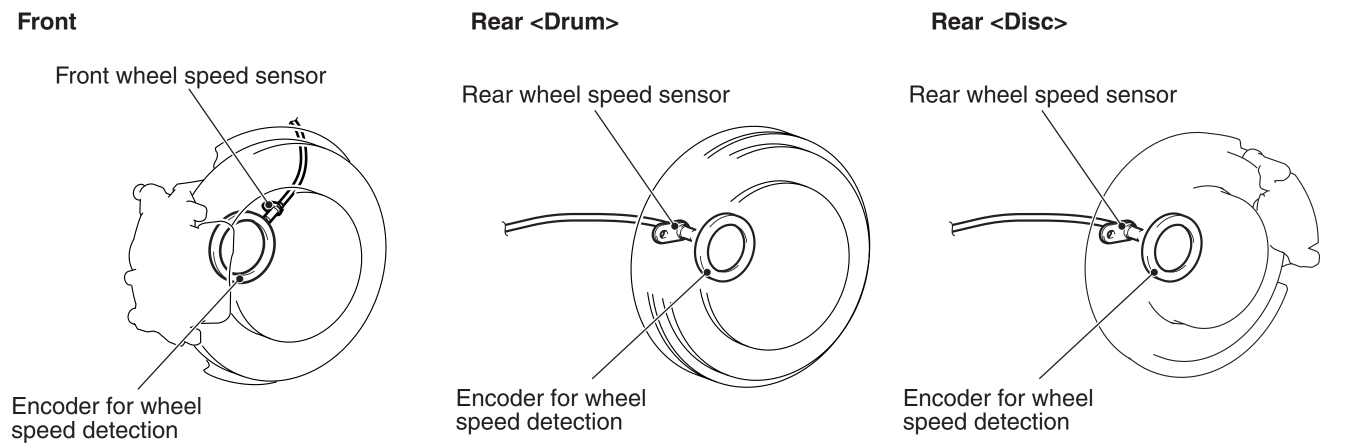
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CONSTRUCTION DESCRIPTION

SENSORS

M2351001000427

WHEEL SPEED SENSORS AND MAGNETIC ENCODER FOR WHEEL SPEED DETECTION



Wheel speed sensor is a kind of a pulse generator consisted of a magnetic encoder (a plate on which north and south pole sides of the magnet are arranged alternately) for wheel speed detection which rotates at the same speed of the wheels, and a speed sensor (semiconductor sensor), sends frequency pulse signals in proportion to wheel speed. Front wheel speed sensor consists of a front wheel speed sensor secured on the knuckle, and a magnetic encoder for wheel speed detection fitted to the inside of the front wheel bearing. Rear wheel speed sensor consists of a rear wheel speed sensor secured on the rear hub, and a magnetic encoder for wheel speed detection press fitted to the rear hub inner ring.

ABS-ECU

M2351003000252

- By integrating ABS-ECU into the hydraulic unit, no more wiring harnesses for sending signal that operates the solenoid valve and pump motor is required, assuring higher reliability.
- Self-diagnostic programs and memory functions are integrated into ABS-ECU. If any malfunction is detected by the self-diagnostic function, ABS-ECU activates a fail-safe function and illuminates ABS warning lamp and brake warning lamp*.

*NOTE: *: ABS-ECU illuminates the brake warning lamp as EBD control warning lamp.*

- ABS-ECU detects vehicle speed from the wheel speed sensor signal, recognizes the wheel rotation, estimates the wheel slip condition based on the preprogrammed algorithm, and then controls the solenoid valve in the hydraulic unit so that the wheels do not lock.

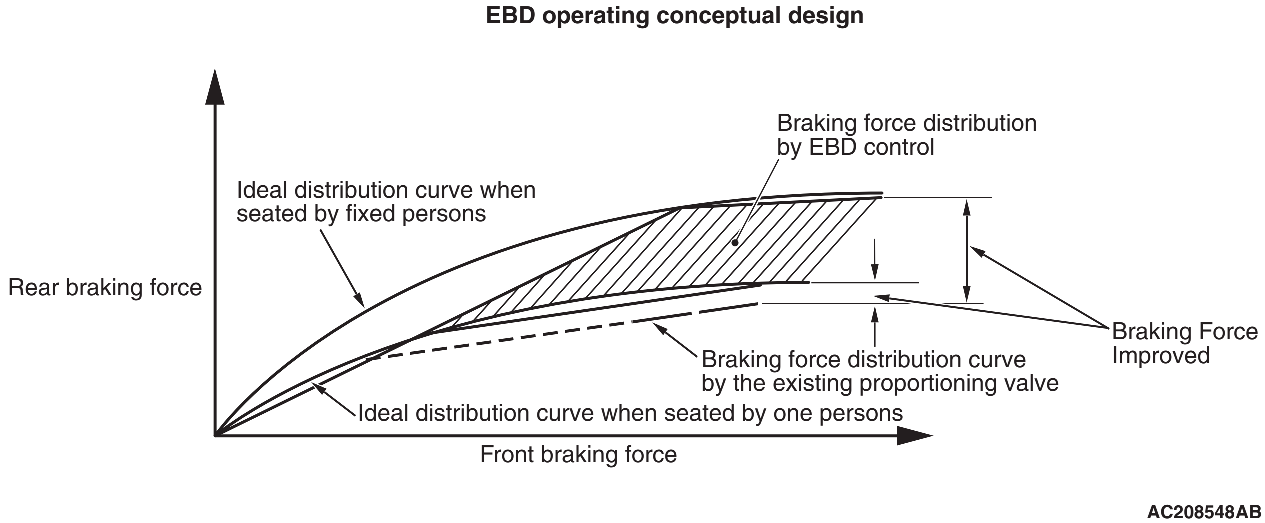
ABS FLUID PRESSURE CONTROL

FOUR-WHEEL CONTROL

ABS fluid pressure is controlled independently for four wheels.

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EBD FLUID PRESSURE CONTROL



EBD control is activated within the lower slip ratio area where ABS is disabled. ABS-ECU calculates vehicle deceleration and slip amount of the four wheels based on the wheel speed sensor signal. If the rear wheel speed differs from the vehicle speed by a certain level or more, ABS-ECU boost, holds, and depressurises the rear wheel control solenoid valve in the hydraulic unit, and then adjusts rear wheel brake fluid pressure fairly close to an ideal distribution curve.

INITIAL CHECK

ABS-ECU internally activates the self-diagnostic function. ABS-ECU illuminates ABS warning lamp for 3 seconds (including the initial check) * after the ignition switch is turned ON. If any malfunction is detected, ABS-ECU continues illuminating ABS warning lamp and disables ABS control.

*NOTE: *: ABS warning lamp may stay ON after the ignition switch is turned ON until the startup vehicle speed reaches approximately 10km/h. As far as ABS-ECU memorizes any diagnosis code related to the wheel speed sensor malfunction recorded during previous ignition ON status, ABS-ECU continues illuminating ABS warning lamp until it verifies that the malfunction for that code is resolved (Startup check).*

STARTUP CHECK

When the startup vehicle speed reaches approximately 10 km/h, ABS-ECU performs the following checks.

- Motor, solenoid valve check (only in initial startup*)

Operates the motor relay in ECU and checks the pump motor operation. At the same time, ABS-ECU sequentially energizes each solenoid valve in a very short period and checks the valve operation.

*NOTE: *: Initial startup indicates a first startup after the system has started.*

- Wheel speed sensor check

ABS-ECU checks for any wheels that have not received wheel speed sensor signal from the startup.

CONSTANT CHECK

ABS-ECU constantly checks the following item.

- ABS-ECU

Performs self-diagnosis in ECU.

- ECU power supply

Checks if ECU power supply voltage reaches within the operational range.

- Wheel speed sensor
  - Monitors the output voltage of the sensor signal wiring harness and checks for abnormal output voltage (open/short circuit).
  - Checks for any wheels that do not send pulse signal while the vehicle is in motion.
  - Checks if wheel speed which is abnormally higher or lower than the vehicle speed is input.
- Pump motor and solenoid valve

Checks that ABS-ECU output signal and the operating condition of the pump motor and solenoid valve agree with each other.

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CAN COMMUNICATION

ABS-ECU outputs ABS warning lamp and EBD warning lamp* illumination request signals to the combination meter through CAN communication.

*NOTE: *: ABS-ECU illuminates the brake warning lamp as EBD control warning lamp.*

FAIL - SAFE FUNCTION

If any malfunction is detected by the self-diagnostic function, ABS-ECU illuminates ABS warning lamp and brake warning lamp*, and it controls ABS and EBD as shown in the following table.

*NOTE: *: ABS-ECU illuminates the brake warning lamp as EBD control warning lamp.*

Diagnosis code No.	Item	Action during fail-safe operation				
		ABS control	**EBD control**	**CAN output**	**Brake warning lamp**	**ABS warning lamp**
C1200	Open or short circuit in wheel speed sensor (FR)	Prohibits control of malfunctioning wheel. Prohibits all wheel control after control is completed.	Two or less wheel Abnormal: Enabled Three or more wheels Abnormal: Prohibits	Output permitted	Two or less wheel Abnormal: OFF Three or more wheels Abnormal: ON	ON
C1201	Wheel speed sensor (FR) system					
C1205	Open or short circuit in wheel speed sensor (FL)					
C1206	Wheel speed sensor (FL) system					
C1210	Open or short circuit in wheel speed sensor (RR)					
C1211	Wheel speed sensor (RR) system					
C1215	Open or short circuit in wheel speed sensor (RL)					
C1216	Wheel speed sensor (RL) system					
C1225	Wheel speed sensor malfunction	System shut-down	System shut-down	Output permitted	ON	ON

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Diagnosis code No.	Item	Action during fail-safe operation				
		ABS control	EBD control	CAN output	Brake warning lamp	ABS warning lamp
C1226	Control solenoid valve (FR) pressure holding system	Prohibited	Prohibited	Output permitted	ON	ON
C1231	Control solenoid valve (FR) decompressing system					
C1236	Control solenoid valve (FL) pressure holding system					
C1241	Control solenoid valve (FL) pressure reducing system					
C1246	Control solenoid valve (RR) pressure holding system					
C1251	Control solenoid valve (RR) pressure reducing system					
C1256	Control solenoid valve (RL) pressure holding system					
C1261	Control solenoid valve (RL) decompressing system					
C1266	Motor system (stuck)	Prohibited	Enabled	Output permitted	OFF	ON
C1273	Motor relay stuck off					
C1274	Motor relay stuck on					
C1276	Valve relay system	System shut-down	System shut-down	Output permitted	ON	ON
C1278	Valve relay system stuck off	System shut-down	System shut-down	Output permitted	ON	ON
C1279	Valve relay system stuck on	Prohibited	Enabled	Output permitted	OFF	ON

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Diagnosis code No.	Item	Action during fail-safe operation				
		ABS control	EBD control	CAN output	Brake warning lamp	ABS warning lamp
C1607	Trouble in ABS-ECU	System shut-down	System shut-down	Output permitted (Output may be impossible).	ON	ON
	Trouble in ABS-ECU (CAN Initialisation malfunction)	Enabled	Enabled	Output impossible	ON *	ON *
C1860	High voltage at ABS-ECU power supply	Wait	Wait	Output permitted	ON	ON
C1861	Low voltage at ABS-ECU power supply	Wait	Wait	Output permitted	ON	ON
U1073	Trouble in CAN bus system	Enabled	Enabled	Output impossible	ON *	ON *

NOTE:
- **: If any trouble occurs in CAN communication, the brake warning lamp and ABS warning lamp on the combination meter turns ON.*
- *Prohibit: Any controls are not performed until the ignition switch is turned OFF.*
- *System shut-down: Control will be disabled until valve power supply is turned off, and then ignition switch is turned to the OFF position.*
- *Wait: ABS control is restarted when the normal condition is resumed even though the ignition switch is not turned OFF.*

DIAGNOSTIC FUNCTION

ABS-ECU has the following functions for easier system checks. The following items can be diagnosed using the M.U.T.-III (ABS warning lamp illuminates and ABS control is prohibited while the ABS-ECU communicates with the M.U.T.-III).

- Diagnosis code set
- Service data output
- Actuator test

DIAGNOSIS CODE SET

There are 28 diagnostic items. Since all the diagnostic results are recorded in volatile memory (EEPROM*), they are stored in the memory even though the battery terminals are disconnected.

NOTE:
- **EEPROM (Electrical Erasable &;Programmable ROM): Special type of memory that can be programmed or erased electrically*
- *For each diagnostic item, refer to Fail-safe Function.*

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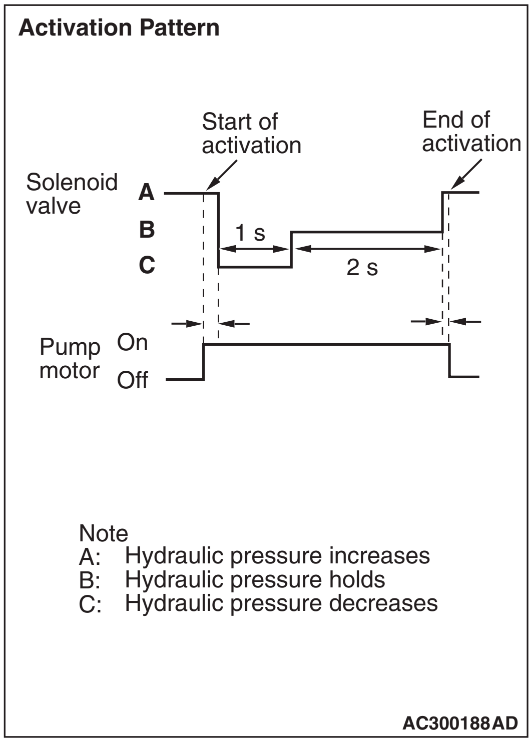
SERVICE DATA OUTPUT

The following items of the ECU input data can be read using M.U.T.-III.

Item No.	Check item	Check condition	Normal condition
01	FR wheel speed sensor	Perform a test run of the vehicle.	Speedometer display and M.U.T.-III display almost agree with each other.
02	FL wheel speed sensor		
03	RR wheel speed sensor		
04	RL wheel speed sensor		
05	Power supply voltage	Always	10 V or more
06	Stop lamp switch	The brake pedal is depressed	ON
		The brake pedal is released.	OFF
07	Valve relay	When ABS is operating	ON
		When ABS is not operating	OFF
10	FL inlet valve	When ABS is operating	ON
		When ABS is not operating	OFF
11	FL outlet valve	When ABS is operating	ON
		When ABS is not operating	OFF
12	FR inlet valve	When ABS is operating	ON
		When ABS is not operating	OFF
13	FR outlet valve	When ABS is operating	ON
		When ABS is not operating	OFF
14	RL inlet valve	When ABS is operating	ON
		When ABS is not operating	OFF
15	RL outlet valve	When ABS is operating	ON
		When ABS is not operating	OFF
16	RR inlet valve	When ABS is operating	ON
		When ABS is not operating	OFF
17	RR outlet valve	When ABS is operating	ON
		When ABS is not operating	OFF
20	Pump motor	When ABS is operating	ON
		When ABS is not operating	OFF

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ACTUATOR TEST



The M.U.T.-III can be used to force-drive all solenoid valves and the pump motor.

NOTE:

- *When ABS-ECU is disabled, the actuator test cannot be performed.*
- *The actuator test can be performed only when the vehicle is stationary. When the vehicle speed reaches 10km/h, the forcible actuator operation is disabled.*
- *During actuator test, the ABS warning lamp illuminates, and ABS control is prohibited.*

Item No.	Check item	Drive Contents
01	Solenoid valve for front-right wheel	Solenoid valves and pump motor in the hydraulic unit (simple inspection mode)
02	Solenoid valve for front-left wheel	
03	Solenoid valve for rear-right wheel	
04	Solenoid valve for rear-left wheel	